Stock Market Efficiency in the Gulf Cooperation Council Countries (GCC): The Case of Kuwait Stock Exchange

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Abstract

This paper, unlike previous studies in stock market efficiency literature on KSE, examines the weak-form efficiency by taking into consideration the institutional features of the KSE. We employ a testing methodology that empowers us to recognize the non-linearity and infrequent trading of the KSE. Furthermore, as a robustness check on the predictability of returns, we employ EGARCH and GARCH-M to account for time-varying risk premia in the KSE. We find that the KSE is weak-form inefficient, even though the efficiency improves towards the end of 1990s. . In order to make the KSE informationally more efficient, the policymakers should improve the liquidity of the market, ensure that participants have access to high quality and reliable timely information, and minimize institutional restrictions on trading.

Key Words: *Stock Market efficiency; Thin Trading; Time-Varying Risk Premium; Liberalization; KSE*

1. Introduction:

This paper examines the market efficiency of a frontier capital market of Kuwait by taking into consideration the role of infrequent trading, non-linearity in emerging stock market and regulatory changes. The liberalization policies pursued by Kuwait since 1992 attracted the Western fund managers in pursuit of high rates of return and portfolio diversification. The issue of market efficiency is of importance for both resource allocation and portfolio investment reasons. In order f or the tests of market efficiency to be reliable and robust, these tests must address the issues of institutional features, trading conditions and liquidity of the market. Most of the stocks in Kuwait Stock Exchange (henceforth, KSE) are thinly traded.

The conventional tests of market efficiency are done in the context of developed equity markets, which are highly liquid, with sufficient numbers of market traders and few institutional barriers. Emerging markets on the other hand are characterized by thin trading, low liquidity, uninformed or traders with incomplete information and high volatility. The efficiency of market is dependent upon the volume of trading, which makes it difficult for traders to react to new information. Large traders have power to manipulate smaller stock markets.

Efficient market assumes rationality, which implies risk aversion, unbiased forecast, and instantaneous response to new information, which leads linear price reaction to new information. A frontier market may lack informed traders in early years of operation, which may introduce non-linearity in price reaction. It has been argued that investors are loss averse and are more sensitive to losses than to gains (Benartzi and Thaler, 1993). Loss averse investors who have incurred losses in the previous period may attempt to recover these losses, thus leading to risk-loving or risk neutral behavior. They may also tend to weigh more their own forecasts, thus introducing bias in their trading behavior. Moreover, uninformed traders may follow the actions of informed traders, thus delaying their own trading. All of these may lead to stock prices reacting to new information non-linearly.

A non-liner 'chaotic' price series is very similar to a random walk. If the stock return series is non-linear and a linear model is used to test for efficiency, one might incorrectly accept the non-predictability. If, however, the series is non-liner, the series may be predictable. Conventional tests such as autocorrelation tests, runs tests, spectral analysis are incapable of capturing non-linearity, and the market efficiency tests in such circumstances may be inappropriate.

Emerging markets by their own nature are evolving over time. Many emerging markets eager to attract more capital to their markets start to eliminate barriers, and enhance their institutional and regulatory environments. These changes will improve efficiency. Therefore, it is necessary to examine these markets overtime rather than take a snap shot of the market at a given point of time.

Butler and Malaikah (1992) used serial correlation and runs tests to evaluate the weak form efficiency of Kuwait stock exchange, and find serial correlation for many Kuwaiti stocks. Al-Loughani (1995), using more robust statistical techniques on Kuwait stock index, finds that the KSE shows stationarity but not random walk. By applying the Beveridge and Nelson (1981) decomposition to observed KSE index levels, Abraham, Seyyed and Alsakran (2002) examines the random walk hypothesis and market efficiency for the KSE by using runs and variance ratio tests. They find weak form market efficiency, but no random walk for the KSE.

This paper, unlike others in this area, examines the issue of market efficiency of the KSE by taking into consideration the institutional features of the KSE. We employ a testing methodology that empowers us to recognize the non-linearity and infrequent trading of the KSE. Furthermore, as a robustness check on the predictability of returns, we employ EGARCH and GARCH-M to account for time-varying risk premia in the KSE. We find that the KSE is weak-form inefficient, even though the efficiency improves towards the end of 1990s.

This paper is divided into six sections. Following introduction in section 1, we provide a brief but comprehensive literature review on the stock market efficiency to motivate our present research in section 2. We provide an overview of the KSE in section 3. Section 4 describes the data and methodology. Section 5 analyzes the results while section 6 concludes the paper.

2. Review of Stock Market Efficiency Literature

Following the seminal work of Fama (1970), a number of studies documented that the stock markets in the developed countries are either weak or semi-strong form efficient. The efficient market hypothesis states that a market is informationally efficient if prices of financial securities reflect all publicly available information and these prices adjust rapidly to the arrival of new information. Therefore, there exists no scope for investors to make trading profit by relying on publicly available information. Fama categorized three forms of market efficiency: weak, semi-strong and strong. These forms differ in terms of the types of information, which are used in developing trading strategies. The three forms of market efficiency can be distinguished in the following way: a. Weak-form efficiency: the information set includes all historical price information; b. Semi-strong form efficiency: the information set includes all publicly available information; c. Strong-form efficiency: the information set includes all public and private information.

2.1. Developed Capital Market Efficiency Studies

Early work on market efficiency centers on the Efficient Market Hypothesis (EMH) and the Martingle model. Cowles and Jones (1937) develop one of the first tests of the Random Walk Hypothesis (RWH). The result of their study does not support the RWH because of the acknowledged error in their analysis. Osborne (1959), Cootner (1962), Fama (1965), Fama and Blume (1966) perform tests on the RWH and their results are supportive of the RWH. However, more recently, Lo and Mackinlay (1988) use daily U.S stock return indexes from 1962-1985 and reject the RWH. The literature reviewed is concerned with efficiency in the U.S.A stock exchanges. Nothing is mentioned about other developed equity markets. A monograph by Hawawini (1984) reviews 280 studies covering 14 western European countries. He concludes that despite the peculiarities of European equity markets, the behavior of these stock prices is similar to those of U.S common stocks. This conclusion holds even for narrow markets such as Finland.

2.2. Emerging Markets Capital Market Efficiency Studies

There is recent interest on the market efficiency of emerging capital markets as market data of these countries are becoming available from public, such as IFIC, and private, such as Morgan-Stanley, sources. Researchers have focused on whether these markets are informationally efficient or whether anomalies exist. Barnes (1986) indicates that the Kuala Lumpur stock market is inefficient. Butler and Malaikah (1992) study the Kuwaiti and Saudi Arabian stock markets. They find that the Saudi stock market is inefficient while the Kuwaiti Stock Market is efficient. Panas (1990) could not reject market efficiency for Greece. El-Erian and Kumar (1995) use indices of prices for the stock markets of Turkey and Jordan. Using the serial correlation and the parametric run techniques, they find both markets to be inefficient. Campbell (1995) examines 20 emerging markets in Latin America, Asia, Middle East, Europe, and Africa. He finds that returns in these emerging markets are more predictable than returns in developed markets and returns are influenced by local rather than global information. Antoniou, Ergul, and Holmes (1997) study the Istanbul Stock Exchange and find it to be inefficient in the early times and efficiency improves as the country starts liberalization and deregulation. Dickinson and Muragu (1994) find the Nairobi stock market to be efficient. Urrutia (1995), using the variance ratio test, rejects the RWH for the Latin American emerging equity markets. Of Argentina, Brazil, Chile and Mexico, whereas the runs test indicates weak form efficiency. In contrast, Ojah and Karemera (1999) find that the Latin American equity returns follow a random walk and are generally weak-form efficient. Grieb and Reyes (1999) reexamine the RWH of equity markets of Brazil and Mexico using the variance ratio tests and conclude that Mexico shows mean reversion and Brazil a RWH.

From the above review, it can be concluded that empirical tests have given mix results about efficiency in emerging markets. For a test to be reliable it should take into consideration the institutional features of these markets. These empirical studies have used the conventional efficiency tests, which have been developed for testing mature markets. Those markets are characterized by high liquidity, few institutional hindrances, reliable information, and sophisticated investors. To the contrary, emerging markets are characterized by low liquidity, thin trading, unreliable information, and less informed investors. Furthermore, the rationality assumption implies that investors are risk averse, instantaneously respond to new information, and make unbiased forecasts. Based on these assumptions we expect prices to respond linearly to the arrival of information.

2.3. Testing Efficiency in Emerging Capital Markets

Market efficiency is concerned with whether prices follow a random walk or are predictable. The assumptions behind the concept of market efficiency imply a linear generation process. However, non-linearity may take place due to non-linear feeding back mechanism in price movement, market imperfection, and the microstructure of the market. Empirical researches have in fact spotted non-linearity in both mature markets and emerging markets. Neftcy (1984) rejects the assumptions of linearity and independence of price changes of stocks. Both Bollerslev (1987) and Akgiray (1987) support the same claim. They both conclude the independence assumption of successive price change is incorrect. The same conclusion is reached from studies on other countries. Koutmos (1992) examines nonlinear dependence in the daily stock returns of the following countries: Belgium, Canada, France, Germany, Great Britain, Italy, Japan, Netherlands, and Switzerland. All the indices exhibit negative skewness and high leptokurtosis. The primary results also indicate that strong nonlinear dependence exists in all of the indices. Savit (1988) suggests that asset returns may be generated by deterministic chaos in which case the forecasting error grows exponentially so that the process appears stochastic. Scheinkman and Barron (1989) claim that stock returns follow a non-linear process. Since non-linearity is found in mature markets, one can expect to find it in emerging markets. In fact, the current nature of these markets may lead to non-linearity. Regulatory changes to enhance trading conditions, disclosure, and listing requirements may be one factor causing non-linearity. Other factors include thin trading, unreliable information, overreaction, high transaction costs, and inside information. In fact Swell, Stansell, Lee, and Pan (1993) examine the daily indices of four emerging Asian markets (Hong Kong, Korea, Singapore, and Taiwan), the Japanese Stock market, and the Unites States stocks. They reject the independence hypotheses for all emerging markets in question. Therefore, market efficiency based on linear models may wrongly lead to the acceptance or rejection of the null hypothesis. Furthermore, thin trading may introduce serial correlation, which may be thought evidence of price dependence and predictability. Therefore, in testing efficiency we have to take non-linearity, thin trading and structural changes in emerging markets into account.

2.4. Overview of Kuwait Stock Market

The stock markets in the GCC are relatively small, listed companies are few and most stocks are infrequently traded, and trading volume is low. Commercial banks dominate the financial markets in the GCC region. The Kuwait stock market started operating soon after its independence from the British in 1961. Speculative trading led to a spiral in stock prices and volume in the over-the-counter market until 1976 when the market collapsed. The Government then put restrictions on listing of new companies in the stock exchange, and made forward trade and margin regulations. By the 1978, the Kuwait stock market stabilized. As a result of the government ban on the creation of public companies, Souk Al-Manakh (a parallel stock exchange) evolved in 1979 as a totally unregulated market in Kuwaiti-owned, Gulf-based companies that did not meet the official exchange listing requirements. Following the authorities' relaxation of the ban on the forward trading in 1981, prices in the parallel and official market rose sharply. The market continued to climb until mid-May 1982. The stock market collapsed. The government since then took a series of reforms to increase the efficiency of the Kuwait stock exchange. These reform measures included the following: the implementation of the daily price change limits system and the written auction system, which is a continuous matching auction system in stock transactions; the division of the market into an official market and a parallel market which included 30

Gulf shareholding companies and five Kuwaiti companies; the registration of brokerage companies and dealers; and the imposition of disclosure rules to increase the transparency of the market. These reform measures have gradually improved the functioning and efficiency of the KSE.

The most actively traded shares are those of investment companies whose principal operating activity is trading in other locally listed company shares. With the exception of commercial banks, the bulk of all listed companies profits are non-operational, originating from trading in other company shares. Accounting reports of most companies are insufficiently informative and usually published several months after the end of the operating year.

The growth and development of the Kuwait stock market is constrained by a number of factors: there is a lack of market makers; foreign access to the market is restricted to GCC- nationals; a significant part of economic activity remains under government control; short selling is illegal; there is no facility for securities lending and borrowing; information disclosure requirements are lax; Government tendency to bail out the speculators; and derivatives are not available.

4. Data and Methodology

4.1. Data

This paper utilizes data from three different sources. The first source is Kuwait Stock Exchange. The second source of data is Central Bank of Kuwait. The third source of data is a private data gathering agency in Kuwait. We have collected a series of daily stock index data from 1995 to 2000.

4.2. Thin Trading and Non-Linearity Methodology

In investigating the efficiency of the Kuwait Stock Exchange, it is necessary to take its characteristics, such as, thin trading, structural changes and the possible non-linearity into account. Returns are calculated using the first log difference for both daily and daily price indices.

$$LnP1 - LnP2 \qquad (1)$$

Where P1, and P2 represent the current and the previous daily market index or individual firm price.

To account for possible non-linearity in the generating process of return, the logistic map equation will be used. This equation takes into account non-linear behavior in stock prices, but does not determine the exact nature of non-linearity.

$$Rt = a_0 0 + a_1 R_{t-1} + a_2 R^2_{t-1} + a_3 R^3_{t-1} + e_t \qquad (2)$$

Where Rt is the return at time t, For a market to be efficient a0 = a1 = a2=a3= 0, and et to be a white noise process.

In addition, emerging markets are characterized by thin trading. Many studies have investigated the effects and consequences of this aspect. These studies include Fisher (1966), Dimson (1979), Cohen (1978, 1979), Lo and Mackinlay (1990), Stoll and Whaley (1990), and Muthuswamy and Whaley (1994). The bias of the infrequently traded shares is brought by prices that are recorded at the end of a time period that have a tendency to represent an outcome of a transaction that occurred prior to the period in question. Hence, thin trading induces serial correlation in the time series of returns. To correct for thin trading, Miller, Muthuswamy, and Whale's (1994) method will be adapted. According to this method, to remove the effect of thin trading we need a moving average model (MA) that reflects the number of non-trading days and then returns must be adjusted accordingly. However, given the difficulties in identifying the number of non-trading days, Miller has shown that it is equivalent to estimate an AR (1) model from which the non-trading adjustment can be obtained. The AR (1) equation is as follows:

$$Rt = a_0 + a_1 R_{t-1} + e_t \qquad (3)$$

Using the residuals from equation (2) to adjust return, the adjusted return is estimated as follows:

$$R_{tadj} = et / (1 - a_1) \qquad (4)$$

where Rtadj is the return at time t adjusted for thin trading. Miller, Muthuswamy, and Whale find thin trading adjustment reduces the negative correlation among returns. The model above assumes that non-trading adjustment is constant over time. While this assumption may be correct for highly liquid markets, it is not the case for emerging markets. Therefore, equation (3) will be estimated recursively. In testing for efficiency, equation (2) is estimated using corrected returns calculated recursively from equation (4). Moreover, efficiency will be examined using the linear and non-linear model to see if the results of both models are different. To trace the effect of structural changes over time, the previous models will be estimated on a daily basis using daily data.

4.2. GARCH and EGARCH Methodology

Black (1976) has found evidence that stock returns are negatively correlated with changes in return volatility, i.e. volatility tends to rise in response to “bad news” (negative excess returns) and to fall in response to good news (positive excess returns).

The Autoregressive Conditional Heteroscedasticity (ARCH) model introduced by Engle (1982) allows the variance of the error term to vary over time, in contrast the classical regression model, which assumes a constant variance. Bollerslev (1986) generalized the ARCH process by allowing for a lag structure for the variance, since stock returns are highly fluctuated the generalized ARCH models, i.e. the GARCH models, have been found to be valuable in modeling the time series behavior of stock returns (Akgiray, 1989; Frinch et al. (1987). Bollerslev (1986) allows the conditional variance to be a function of the lag’s squared errors as well as of its past conditional variances.

The higher order ARCH and GARCH models introduced by Engle (1982) and Bollerslev (1986) respectively are

$$\sigma_t^2 = \omega + \sum_{j=1}^{p} \alpha_j \varepsilon_{t-1}^2 + \sum_{j=1}^{p} \alpha_j Z_{t-j}^2 \sigma_{t-j}^2$$

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} B_j \sigma_{t-1}^2 + \sum_{j=1}^{p} \alpha_j Z_{t-j}^2 \sigma_{t-j}^2$$

Where

$$\varepsilon_t = \sigma_t Z_t$$

$$Z_t \approx i.i.d..with$$

$$E(Z_t) = 0, \quad Var(Z_t) = 1, \;\; and$$

$$\sigma_t^2 = \sigma^2(\varepsilon_{t-1}, \varepsilon_{t-2}, \varepsilon_{t-3}, ...)$$

Nelson (1991) shows that (6) can be written as

$$\sigma_t^2 = \omega + \sum_{k=1}^{\infty} \phi_k Z_{t-1}^2 \sigma_{t-k}^2 \qquad (7)$$

Where and are nonnegative parameters. Nelson contradicts generalized ARCH models in that GARCH models assumes that only magnitude and not the positivity or negativity of unanticipated excess returns determine the conditional variance. If the distribution of Zt is asymmetric, the future change in variance is conditionally uncorrelated with excess returns today. In (5) and (6), is a function of lagged and lagged , and so invariant to changes in the algebraic sign of Zt. (i.e. only changes in the algebraic sign, of lagged residuals determines conditional variance). This suggests a model in which respond asymmetrically to positive and negative disturbance is preferable for empirical studies of assets pricing. Another limitation that Nelson (1991) suggests, results from the non-negativity constraints on and in (7) that is imposed in GARCH and GARCH-M models to insure nonnegative conditional variance.

The EGARCH or Exponential GARCH model was proposed by Nelson (1991). The specification for the higher order conditional variance is

$$Log(\sigma_t^2) = \omega + \sum_{j=1}^{p} B_j \log(\sigma_{t-j}^2) + \left(\sum_{i}^{q} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \gamma_i \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right) \qquad (8)$$

Note that the left hand side of the equation is the log of the conditional variance. This implies that the asymmetric effect is exponential, rather than quadratic, and that forecasts of the conditional variance are generated to be nonnegative. The presence of leverage effects can be tested by the hypothesis that the impact is asymmetric if As the original GARCH model, the size and significance of indicates the magnitude effect imposed by the lagged error term () on conditional variance. In other words, the size and significance of implies the existence of the ARCH process in the error term (volatility clustering).

5. Empirical Results

In testing for the efficiency of the Kuwait Stock index, we proceed in the following ways. First, the techniques used in testing the efficiency in mature markets will be applied in testing the efficiency in the Kuwait stock market. The methods that will be used are the serial correlation test and the linear model that is represented by equation (3). One of the most direct and intuitive tests of the random walk hypotheses for an individual time series is to check for serial correlation between two observations of the same series at different dates. Under the weakest version of the random walk, the increments or first-differences of the level of the random walk are uncorrelated at all leads and lags. Therefore, we may test the weak form of efficiency by testing the null hypothesis that the autocorrelation coefficients of the first differences at various lags are all zero. The second method for testing the efficiency in the KSE is the linear model represented in equation 3. The daily stock price index for the period starting from November 1995 through December 1999 is used for empirical analysis. Second, to take into account the possible non-linear generating process of returns, equation (2) will be estimated for the whole period. Third, after adjusting for thin trading by using Miller, Muthuswamy, and Whaley's method and Antoniou and Ergul (1997) technique, equations 2 and 3 will be estimated again. Fourth, to trace the development of efficiency of the market over the time, the above procedures will be repeated each year. If the Kuwait market is efficient, we expect a1, a2 and a3 (the coefficients of lagged return) to be insignificantly different from zero.

Table 1 shows the coefficient of the linear model using the OLS method for the whole period. From the coefficient of lagged return, we can we reject the null hypothesis of market efficiency for the full period and for 1996 and 1997. We, however, cannot reject the null hypothesis for the years 1998 and 1999. It appears that the Kuwait stock market was weak form inefficient during the initial periods, but became efficient during 1998 and 1999. This may be due to the reform and regulations instituted in the KSE.

To take into account any possible non-linearity in the return generating process that might affect the efficiency of the KSE, we incorporate a non-linear term into the model. It is clear that the conclusion about weak form market inefficiency does not change. Table 2 shows the OLS results applied to the non-linear model or equation (3). A number of higher order lagged coefficient terms are significant indicating the possible non-linearity in the stock market data. Even after we account for the non-linearity, we still find that the KSE market is generally weak form inefficient, although the market efficiency improves during the end of the sample period.

Thin trading is one of the characteristics of emerging markets. If it is not taken into account when studying market efficiency, we may reach the wrong conclusion. Table 3 gives the result when we adjust for thin trading using the linear model. It is again clear from the coefficient of adjusted lag return that the market is weak form inefficient during the whole sample period. Table 4 gives the outcome when we adjust for thin trading and include non-linearity into the model. The coefficient of the adjusted lagged error term is significantly different from zero, which implies the Kuwait stock market is inefficient. The coefficients of non-linear terms are statistically significant implying that the return generating process is non-linear. Therefore, we can conclude that when we adjust for thin trading and incorporate non-linearity into the model, we can confidently reject the weak form efficiency for the KSE.

Non-Linearity may result from time-varying risk premia in the stock market. In order to check the robustness of the results with respect to this, we examine whether the pattern of predictability is evident when we include a measure of time-varying risk parameter in the model. We employ GARCH-M and EGARCH models to incorporate time-varying risk parameters in the return generating which also incorporates the non-linearity, and think trading. Other results still remain the same. The ARCH and GARCH effects are present in the data because the coefficients are statistically significant in both models. The KSE is still weak form efficient. We observe asymmetric reaction in the stock return generating process.

6. Conclusion

This paper examines the weak form efficiency of the Kuwait Stock Market taking into account the characteristics prominent in emerging markets. These characteristics include non-linearity, and thin trading. Correction has been made to accommodate thin trading and possible non-linearity. The results do not support the null hypothesis of market efficiency for the whole study period and earlier sub periods. However, the results indicate the market efficiency of the Kuwait stock market is improving. The primary lesson we learn from this empirical research on the KSE is that it is inefficient. The results are robust even after we account for thin trading, non-linearity and time varying risk premia in the stock return generating process.

Our study period covers the aftermath of various important regulatory reforms carried out in the KSE. The important regulatory reforms include daily price limits, the hands-off policy of the government in the free functioning of the capital market and the off-loading of government shares in a number of companies. Our results of weak form inefficiency of the KSE are consistent with prior research even though, unlike previous research, we use improved methods, which consider the peculiarities of the emerging stock market. The reforms of the 1980s and the developments of the 1990s did not contribute much to the efficiency of the KSE. In order to make the KSE informationally more efficient, the policymakers should improve liquidity, ensure that participants have access to high quality and reliable information, and minimize institutional restrictions on trading.

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Table 1

Random walk model with out non-linearities for uncorrected returns for KSE index

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t$$

Periods	α_0 (T-statistics)	α_1 (T-statistics)	$\chi^2(2)$ [1]	$F^{(2)}$ χ^2
1 - (Nov.1995- Dec.1999)	.0000243 (.095980)	.159793* (5.19351)	134.150*	.970636 92.31*
2- (Jan. 1996-Dec. 1996)	.000988821* (2.92174)	.267567* (4.36633)	1.75125	1.33691 101.01*
3- (Jan. 1997-Dec. 1997)	.00104574 (2.45728)	.163786* (2.66626)	3.63936	9.90705* 51.03*
4- (Jan. 1998-Dec. 1998)	-.00181020 (-2.37686)	.140867 (2.23721)	19.0455*	.251607 42.63*
5- (Jan. 1999-Dec. 1999)	-.000326314 (-.736238)	.069305 (1.09251)	1.11741	8.28004* 47.92*

- * indicates Significant at 1 %.
- 1/ LM test for heteroscedasticity. Ho: is the series is homoscedastic. Ha: is otherwise.
- 2/ Ramsey RESET Test. Ho: the functional form is correct. Ha: otherwise.
- 3/ Ljung-Box Q test is significant for the residuals is found to be significant for 52 lags.

Table 2

Random walk model with non-linearities for uncorrected returns for KSE index.

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R^2_{t-1} + \alpha_3 R^3_{t-1} + \varepsilon_t$$

Periods	α_0 (T-statistics)	α_1 (T-statistics)	α_2 (T-statistics)	α_3 (T-statistics)
1 - (Nov.1995- Dec.1999)	-.0000149957 (-.054964)	.356588* (8.44499)	.272904 (.166081)	-473.894* (-6.68064)
2- (Jan. 1996- Dec. 1996)	.000779804 (2.07794)	.311214* (3.43111)	5.67729 (1.03190)	-316.287 (-.755393)
3- (Jan. 1997- Dec. 1997)	.000103788 (.225041)	.380607* (4.44288)	15.1708* (3.72958)	-834.547* (-3.54321)
4- (Jan. 1998- Dec. 1998)	-.00192976 (-2.23677)	.408477* (4.32622)	2.83585 (.923431)	-476.745* (-3.70820)
5- (Jan. 1999- Dec. 1999)	.0000208181 (.040764)	.217159 (2.57019)	-3.70187 (-.545368)	-356.939 (-1.40475)

1/* indicates Significant at 1 %.

Notes

1- $\chi^2(9)$ is Chi-square statistics for White's test for heteroscedasticity. Its statistics are 53.35, 196.38 and 152.68 for the three periods respectively. Ho is the series is homoscedastic.

2- F and χ^2 test are for Ramsey RESET Test for functional form. Ho: the functional form is correct. Ha: otherwise. F statistics is 2.005, 3.08***, and 5.214** for the three periods respectively. And for χ^2 statistics are 2.381398, 3.08883***, and 5.216362** respectively for the three periods.

3- Ljung-Box Q test is significant for the residuals are found to be significant for 48 lags.

Table 3

Random walk model without non-linearities for corrected returns for thin trading of KSE index.

$$R_t = \alpha_0 + \alpha_1 R^{adj}_{t-1} + \varepsilon$$

Periods	α_0 (T-statistics)	α_1 (T-statistics)	$\chi^2(2)$ [1]	$F^{(2)}$ χ^2
1 - (Nov.1995- Dec.1999)	.0000329252 (.129560)	.159213* (5.10252)	118.080*	3.47137 79.63*

- 1/ LM test for heteroscedasticity. Ho: is the series is homoscedastic. Ha: is otherwise.
- 2/ Ramsey RESET Test. Ho: the functional form is correct. Ha: otherwise.
- 3/ Ljung-Box Q test is significant for the residuals is found to be significant for 48 lags.

Table 4

Random walk model with non-linearities for corrected returns for thin trading of KSE index.

$$R^{adj}_t = \alpha_0 + \alpha_1 R^{adj}_{t-1} + \alpha_2 R^{2adj}_{t-1} + \alpha_2 R^{3adj}_{t-1} + \varepsilon_t$$

Periods	α_0 (T-statistics)	α_1 (T-statistics)	α_2 (T-statistics)	α_3 (T-statistics)
1 - (Nov.1995- Dec.1999)	-.0000164924 (-.060323)	.166745* (3.93660)	.501714 (.298094)	-376.543* (-5.68019)

- * indicates Significant at 1 %.

Notes

1. $\chi^2(9)$ is Chi-square statistics for LM test for heteroscedasticity. Its statistics are 464.65, 429.168, and 144.828 for the three periods respectively.
2. F and χ^2 tests are for Ramsey RESET Test for functional form. Ho: the functional form is correct. Ha: otherwise. F statistics is 0.495720, 1.417710, and 0648367 for the three periods respectively. And the χ^2 statistics are 0.497801, 1.420264, and 0.649229 respectively for the three periods.
3. Ljung-Box Q test is significant for the residuals is found to be significant for 48 lags.

Table 5

GARCH-M(1,1) with non-linearities and thin trading corrected returns of the KSE

$$R^{adj}_t = u_1 + u_2 R^{adj}_{t-1} + u_3 R^{2adj}_{t-1} + u_4 R^{3adj}_{t-1} + \delta_1 h_t + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta_1 h_{t-1}$$

Period	u_1	u_2	u_3	U_4	δ_1	α_0	α_1	β_1
95-2000	.0004	.2075*	.02559	.0321	-.02954	.0001*	.321*	(.685)*
P-Value	(.3292)	(.000)	(.425)	(.3212)	(.7061)	(.000)	(.000)	(.000)

Table 6

EGARCH-M(1,1) with non-linearities and thin trading corrected returns of KSE

$$R^{adj}_t = u_1 + u_2 R^{adj}_{t-1} + u_3 R^{2adj}_{t-1} + u_4 R^{3adj}_{t-1} + \delta_1 h_t + \varepsilon_t$$

$$\text{Log } h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta_1 /\varepsilon_t/h_{t-1}/ + B2\ \varepsilon_t/h_{t-1}$$

Period	u_1	u_2	u_3	u_4	δ_1	α_0	α_1	β_1	β_1
95-2000	.001	.1847*	.01531	.02850	.0045	-5.310*	.73627*	-.0787*	.51894*
P-Value	.8069	.000	.5302	.2073	.9661	.000	(.000)	(.0427)	(.000)